REVIEW

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Interface Control Document (ICD) Between the Image Assessment System (IAS) and the Level 1 Product Generation System (LPGS)

August 1997

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

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Preface

This interface control document (ICD) provides a current understanding of the definition of the information and products exchanged between the Image Assessment System (IAS) and the Level 1 Product Generation System (LPGS) in support of the Landsat 7 mission. This document is controlled by the IAS/LPGS Project Configuration Management Board (PCMB), Code 514.

Abstract

This interface control document (ICD) presents the functional, performance, operational, and design requirements for the interface between the Image Assessment System (IAS) and the Level 1 Product Generation System (LPGS) in support of the Landsat 7 mission.

Keywords*: Image Assessment System (IAS), interface control document (ICD), Level 1 Product Generation System (LPGS)*

Change Information Page

List of Effective Pages	
Page Number	**Issue**
Title page	Original
iii through x	Original
1-1	Original
2-1 through 2-2	Original
3-1 throuhg 3-3	Original
A-1 through A-2	Original
AB-1 through AB-2	Original

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Contents

Preface

Abstract

Section 1. Introduction

Section 2. Interface Description

Section 3. Interface Design

REVIEW

Figure

Appendix A. Radiometric Characterization Parameters

Abbreviations and Acronyms

Section 1. Introduction

1.1   Purpose

This interface control document (ICD) defines the data transfer interface between the Earth Science Data and Information System (ESDIS) Level 1 Product Generation System (LPGS) and the Image Assessment System (IAS) in support of the Landsat 7 mission. This document also contains specific details on the data transferred between the LPGS and the IAS.

1.2   Scope

This ICD describes only the direct interface and data transfer between the LPGS and the IAS. Data that are passed indirectly from the IAS to the LPGS, such as the calibration parameter file (CPF) that is packaged with each image, are not addressed in this document.

1.3   Applicable Documents

1.   National Aeronautics and Space Administration (NASA), Goddard Space Flight Center (GSFC)/MO&DSD, 430-15-01-002-0, *Landsat 7 Detailed Mission Requirements*, May 1995

2.   --, *Mission Operations Concept for the Landsat 7 Ground System*, June 1995

3.   --, 430-15-01-001-0, *Landsat 7 Image Assessment System (IAS) Element Specification*, October 1996

4.   --, 505-10-36, *Earth Science Data and Information System (ESDIS) Project Mission-Specific Requirements for the Landsat 7 Mission Level 1 Processing*, December 1996

5.   --, 510-FPD/0196, *Earth Science Data and Information System (ESDIS) Level 1 Product Generation System (LPGS), Functional and Performance Requirements Specification*, February 1997

6.   --, *Landsat 7 Image Assessment System (IAS) Operations Concept*, Draft, December 1994

7.   --, 510-3OCD/0296, *Level 1 Product Generation System (LPGS) Operations Concept*, February 1997

8.   --, *IAS Radiometric Algorithm Descriptions*, January 1997

9.   *Oracle SQL*Net TCP/IP User's Guide*

10.   The Wollongong Group, Inc. *WINS TCP/IP Primer*, June 1987

11.   MIL-STD-1778, *Transmission Control Protocol*, August 1983

12.   NASA GSFC, 510-4DDS/0197, *ESDIS Level 1 Product Generation System (LPGS) Detailed Design Specification*

13. TBS, Earth Resources Observation System Data Center (EDC), *Landsat 7 Data Handling Facility (DHF) Network System Description*, June 1997

Section 2. Interface Description

The interface between the LPGS and the IAS is unidirectional. The LPGS will collect radiometric characterization data and statistics on each scene processed to at least Level 1R (L1R). These data will be retrieved by the IAS through the use of SQL*Net queries via the EDC Exchange local area network (LAN).

2.1 Purpose of the Interface

The purpose of the interface is to provide a mechanism for the LPGS to provide radiometric characterization data and statistics to the IAS for trending and analysis.

2.2 IAS Description

The IAS is a Landsat 7 element located at the Earth Resources Observation System (EROS) Data Center (EDC) in Sioux Falls, South Dakota. As an element of the ground data handling segment, the IAS is responsible for the offline assessment of image quality to ensure compliance with the radiometric and geometric requirements of the spacecraft and the Enhanced Thematic Mapper Plus (ETM+) sensor throughout the life of the Landsat 7 mission. Operational activities occur at the EDC, and less frequent assessments and calibration certification are the responsibility of the Landsat 7 Project Science Office at the Goddard Space Flight Center (GSFC).

The IAS characterizes radiometric artifacts, including such image quality features as dropped lines, noise and saturated detectors, through a series of algorithms within the L1R processing capability. The outputs of the algorithms and their statistics are captured in a relational database for trending, analysis, modeling, and calibration. The IAS processes a sample averaging 10 scenes a day for image quality assessment, radiometric and geometric calibrations and characterizations, and artifact correction.

2.3 LPGS Description

The LPGS is a source of ETM+ L1 data within the Earth Observing System (EOS) Ground System (EGS). The EGS is a collection of ground support elements for EOS and includes the EOS Data and Information System (EOSDIS), institutional support elements, affiliated and international partner data centers, international partner instrument control and operations centers, and other sources of data. The LPGS is located at the EDC, within the Distributed Active Archive Center (DAAC), and provides ETM+ L1 product generation on demand. The LPGS will process on the order of 25 scenes daily to satisfy user requests.

Nominally, the LPGS uses the same algorithms for the generation of L1 products that the IAS uses within its L1 processor. This allows the LPGS to provide additional characterization data, captured in the same way, to the IAS for trending and analysis.

2.4 Data Flow Summary

Figure 2-1 represents the data flow across the interface between the LPGS and the IAS.
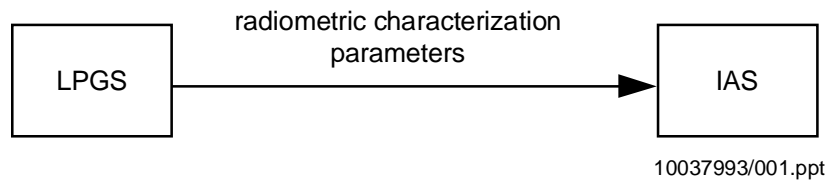

Figure 2-1. LPGS-to-IAS Data Flow

Section 3. Interface Design

This section describes the radiometric characterization parameters—the only information and product transferred between the LPGS and the IAS. Characterization parameters are made available to the IAS only for products generated from completed product requests, that is, those products successfully generated by the LPGS and sent to the ECS for subsequent distribution to users.

3.1   Description

This section summarizes the LPGS radiometric characterization data captured (listed below as b-i), for each scene processed, from the algorithms (see Appendix A for more detailed information). The scene information (listed below as a) is captured by the LPGS and related to each data item such that later trending and analysis can be accomplished with full knowledge of the scene characteristics. The relevant LPGS tables from which the data are retrieved include trending and ingest tables documented in the LPGS Detailed Design Specification (Reference 13). The captured data are

a.   Scene information—Scene identification parameters

b.   Level 0R characterizations—Product assessments from initialization and ingest processes

c.   Impulse noise—Location and value of impulse noise

d.   Detector saturation—Locations of A/D and analog saturation effects

e.   Scan correlated shift—Scan correlated shift states of each scan line

f.   Histogram analysis—Various statistics gathered from L0R data and L0Rc data (corrected for radiometric artifacts)

g.   Internal calibrator, reflective bands (bands 1-5, 7, and 8)—Shutter and pulse values and statistics from the onboard calibration lamp

h.   Internal calibrator, emissive band 6—Shutter and pulse values and statistics from the onboard black body source

i.   Banding—Global figure of merit of banding

3.2   Format

A table of characterization results, as described in Appendix A, will be maintained in the LPGS in Oracle database table format. The LPGS will make trending table records containing characterizations results from completed product requests available for replication onto the IAS system via Oracle SQL*Net. Database queries will be generated by the IAS. The tables to be accessed and transferred consist of trending table and ingest tables (scene, L0R ingest, and PCD).

3.3   Delivery Schedule

The IAS retrieves trending data from the LPGS trending tables as needed. The IAS will identify, via database table update, trending records that have been retrieved by the IAS and no longer need to be retained by the LPGS. The LPGS does not retain characterization parameters results that have been retrieved successfully by the IAS. The LPGS will retain trending data for TBS time.

3.4   Physical Connectivity (Network Connectivity)

Radiometric characterization data are transferred electronically using the EDC Exchange local area network (LAN). The network is described in the *Landsat 7 DHF Network System Description* (Reference 14).

Using Oracle SQL*NET communication software through the EDC Exchange LAN, the Oracle SQL queries are used to retrieve characterization parameter records from completed work orders from the LPGS trending table.

3.5   Volume Estimate

TBS

3.6   Session Layer

The session layer provides system-dependent, process-to-process communications functions, which include

- Receipt and processing of incoming and outgoing logical link connect, disconnect and abort requests

- Receipt and processing of incoming and outgoing data

- Detection of network disconnects and failure of the transport layer to deliver data in a timely manner

SQL*Net is the Oracle communications component that allows the sharing of information stored in different databases. SQL*Net allows applications to connect to multiple Oracle databases across a network using a variety of communications protocols, including Transmission Control Protocol (TCP)/Internet Protocol (IP), and application program interfaces such as Structured Query Language (SQL).

The role of SQL*Net in the IAS-LPGS interface is to connect the client application (an SQL query from the IAS) with the remote database server (on LPGS). SQL*Net enforces security at the table access level as well as at the logon (userid/password) level.

The protocol governing this layer is described in the *Oracle SQL*Net TCP/IP User's Guide* (Reference 10).

3.7 Transport Layer

The transport layer provides a system-independent, process-to-process communications source in association with the underlying services provided by the lower layers. The transport layer permits two systems to exchange data reliably and sequentially, regardless of their location within a network.

TCP is the standard transport-level protocol that provides the reliable, full-duplex, stream service on which many application protocols depend. TCP allows a process on one machine to send a stream of data to a process on another. It is connection oriented (i.e., before transmitting data, participants must establish a connection). This layer complies with the TCP standard as specified in the Internet RFC.

The TCP protocol governing this layer is described in the *Transmission Control Protocol* (Reference 12) and the *WINS TCP/IP Primer* (Reference 11).

3.8 Session Scenario

The following are the steps in a data retrieval session:

1. LPGS generates trending data in a database.

2. IAS connects to the LPGS database.

3. IAS performs query to retrieve changes since last retrieval.

4. IAS marks LPGS records that no longer need to be retained.

5. IAS marks LPGS records that no longer need to be retained.

Appendix A. Radiometric Characterization Parameters

Source/ Algorithm	Content	Number of Values
Scene Information	Source: LPGS Work order: Unique LPGS-assigned work order Orbit position (WRS path/row) Start scan time (in seconds from Jan. 1, 1993) End scan time (in seconds from Jan. 1, 1993) ETM+ on time since on ETM+ off time since off IC and focal plane temperatures (from converted PCD) Lamp states (from PCD) Gain states per band (from MSCD) Scan direction per scan	const. alpha
Characterize 0R Product	PCD quality data—Ephemeris, attitude, star sighting data, gyro data, ADS data, time data, temperature data MSCD quality data—Scan error data, scan data, line length data Attitude statistics—Sums of frequency ranges	
Characterize Impulse Noise	Impulse noise for scene and IC data Band number Detector number Scan number Minor frame number 3-element array containing output values of corrupted minor frame and its neighbors	
Characterize Detector Saturation	Locations of A/D saturation for scene and IC data Band number Detector number Minor Frame number Location of analog saturation for scene and IC data Band number Detector number Minor Frame number	
Locate Scan Correlated Shift	Detector number Scan line number Scan correlated shift state (+1 or -1)	

REVIEW

Source/ Algorithm	Content	Number of Values
Histogram Analysis	Raw histograms of 0R data by detector, by band Saturation bins of 0R data Saturation bins of 0Rc data Means and standard deviations by detector (before bias removal) Means by detector (after bias removal) Number of high and low brightness pixels excluded per detector Number of pixels used in calculations per detector Computed gain rations; four sets per window (reference or average, based on mean or standard deviation) Computed relative biases; two sets per window (reference or mean) Differences of gains calculated between mean method and standard deviation method Differences in relative bias between forward and reverse scans Gain ratios (based on standard deviations and means) for forward-to-reverse scans Along track FFTs	
Process Internal Calibrator Data—Reflective Bands (bands 1-5, 7, and 8)	Integrated shutter value for scene Shutter value standard deviation for scene Number of shutter value outliers per detector Calibration lamp pulse mean for scene Calibration lamp pulse standard deviation for scene - Pulse height - Pulse minima - Pulse width - Pulse location Detector gain and standard deviation (for each band)	
Process Internal Calibrator Data—Emissive Band (band 6)	Scans with pulse outliers Mean shutter values and standard deviation (per scan) Integrated pulse values per scan Gain by scene for each detector Offsets by scan for each detector Scene and net offsets for each detector for each gain state Offset uncertainties Noise levels for each detector Gain outliers Detector gain and standard deviation (for each band)	8
Banding	Global figure of merit	

Abbreviations and Acronyms

A/D	TBS
ADS	Angular Displacement Sensor
CPF	calibration parameter file
DAAC	Distributed Active Archive Center
EDC	EROS Data Center
EGS	EOS Ground System
EOS	Earth Observing System
EOSDIS	EOS Data and Information System
EROS	Earth Resources Observation System
ESDIS	Earth Science Data and Information System
ETM+	Enhanced Thematic Mapper Plus
FFT	Fast Fourier Transform
GSFC	Goddard Space Flight Center
IAS	Image Assessment System
IC	internal calibrator
ICD	interface control document
IP	Internet Protocol
L0R	level zero R data
L0Rc	level zero R data with artifacts corrected
L1	level 1
LAN	local area network
LPGS	Level 1 Product Generation System
MSCD	mirror scan correction data
PCD	payload correction data
PCMB	Project Configuration Management Board
SQL	Structured Query Language
TBD	to be defined/determined

REVIEW

TBR	to be resolved
TBS	to be supplied
TCP	Transmission Control Protocol
WRS	worldwide reference system